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The Dynamic Impact of Environmental Sustainability, Green Finance, and FinTech on Energy Efficiency in Middle Eastern Economies

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ABSTRACT

Middle Eastern countries have prioritized energy efficiency in their policy, regarding the adverse environmental consequences of relying heavily on fossil fuels. Over time, their reliance on fossil fuels for energy generation and imports has resulted in a continual rise in greenhouse gas emissions. Nevertheless, Middle Eastern countries possess considerable capacity for renewable energy resources that can be utilized without causing harm to the environment. This study empirically examines the effect of green finance, environmental sustainability, and fin-tech on energy efficiency using panel data from 2012 to 2023 in Middle Eastern countries: Turkey, Saudi Arabia, Kuwait, Qatar, and the United Arab Emirates. The study achieved its aims by employing a range of econometric methodologies. The CIPS and IPS procedures are employed to analyze unit root attributes, while the panel cointegration methodology of Westerlund (2007) is used to examine cointegration. The results indicate that there is cointegration among the variables that were analyzed. The outcomes provide helpful knowledge regarding the development of energy efficiency in Middle Eastern countries.

Keywords: FinTech, Green Finance Westerlund Test, Middle East
JEL Classifications: F18, F13, Q53, Q56, F1

1. INTRODUCTION

Climate change is one of the environmental challenges directly linked to energy production and use, causing increasing concern (Al-Kasasbeh et al., 2023). Middle Eastern countries face the difficulty of excessive energy consumption compared to other wealthy countries (Alquliti, 2022). One approach that Middle Eastern governments are adopting to decrease energy use is by implementing financial incentives. Climate change is widely acknowledged as the foremost peril to the planet and is expected to exert considerable influence over the political and economic environment for a significant period (Zhou et al., 2024; Udeagha and Ngepah, 2023). Shifting from traditional power consumption to renewable electricity remains one of the most optimal and efficient methods now accessible. Middle Eastern nations have a significant reliance on fossil fuels as a means to propel their economic development.

Globally, several countries are actively pursuing energy efficiency as a key objective to provide economic gains and promote environmental sustainability (Taskin et al., 2022; Guang-Wen and Siddik, 2023; Alkasasbeh et al., 2023). Multiple causes and sectors contribute to the advancement of energy efficiency. Each industry has a distinct influence on energy efficiency and the methods to achieve economic and sustainable development. This research investigates the possible effects of financial factors on energy efficiency and economic growth.

To achieve the UN Sustainable Development Goals related to climate change, an annual investment of approximately 5-7 trillion dollars is required to promote the growth of environmentally sustainable businesses (Al-Kasasbeh et al., 2022; Zia et al., 2024). The current green financial channel is inadequate, and it is important to use fintech to enhance green finance quickly. However, the specific way in which fintech and green finance can speed up the achievement of sustainable growth for companies is still unclear. Therefore, it's important to study the link between fintech, green finance, sustainable development, and energy efficiency, as it is significant both in theory and practice.

2. LITERATURE REVIEW

2.1. Green Finance and Energy Efficiency

A small number of scholars have focused their attention on the topics of green finance and energy efficiency. A consortium of academics demonstrated that green finance is not an effective instrument in numerous nations due to a multitude of fundamental issues. Fu and Ng (2021) showed that green finance instruments, such as green bonds, display inefficiency in developing or less developed economies due to the weak private sector and inadequate financial infrastructure. Rasoulinezhad and Hesary (2022) conducted a study to investigate the relationship between green bonds and several economic and environmental indicators. Their findings align with previous research since they determined that there is no causal connection between green bonds and the other variables examined. Prakash and Mahdvi (2020) discovered that there is no correlation between green bonds and Sustainable Development Goals (SDGs) in India. This is mostly because of a financial shortfall in the private sector and the absence of instructions within India's climate action plan.

In their study, Gibon et al. (2020) examined the green bonds issued by the European Investment Banks specifically to finance green power facilities. The results indicated ineffective deployment of funds, which counteracted the positive impact of green financing on green projects. Charles and Philip (2020) found no association between green bonds and Sustainable Development Goals. The main reason for this is a lack of funding in the business sector and the lack of clear guidelines in India's climate action plan. Contrary to the studies that have found neutral or negative impacts of green finance, a group of studies has depicted the beneficial role of green financing on different macroeconomic variables. For example, Nguyen et al. (2021) conducted a study on the relationship between green bonds, clean energy, and other factors from 2008 to 2019. They presented compelling evidence of the influence of green bonds on the advancement of clean energy. Similarly, Naeem et al. (2021) discovered that green bonds were more effective than traditional bonds during the COVID-19 era due to their increased transparency in interest rates and investment returns.

As a result, the development of green financing has the potential to significantly increase the number of green energy projects. According to Meo and Abd Karim (2022), market conditions and the green finance market mechanism play crucial roles in establishing a favorable correlation between green finance and green energy projects. According to Polzin and Sanders (2020), green finance has the potential to facilitate the achievement of sustainable renewable energy development in countries by drawing in private investors and fostering collaboration between the public and private sectors.

Therefore, it is important to note that the impact of utilizing green finance varies across countries and is dependent on numerous factors. Hence, conducting a study on green finance in a consortium of leading nations that endorse this novel kind of financing would be pragmatic and yield fresh perspectives for these economies as well as for other nations aspiring to establish green finance markets. It is important to examine the relationship between this variable and energy efficiency, as well as the consumption of green energy in these economies. This is crucial because of their contribution to achieving the Sustainable Development Goals set by the United Nations in 2015.

2.2. FinTech and Energy Efficiency

Recently, there has been a significant increase in the quantity of research focused on the use of modern FinTech. The expanding corpus of literature has been enriched by significant research conducted by Teng and Shen (2023) as well as Shkodina et al. (2018). According to Al-Kasasbeh et al. (2023), FinTech is characterized as innovative ideas that improve the functioning of financial services through technology-driven solutions that are tailored to the specific needs of individual companies. Fintech refers to a broad spectrum of financial innovations, such as mobile payment platforms, high-frequency trading, crowdfunding, virtual currencies, and blockchains (Vives, 2017; Karaki and Al-Kasasbeh, 2024). Specialists are increasingly interested in fintech in today's globe because of the rising demand for environmentally careful and user-friendly products and services. By leveraging fintech, financial institutions can expedite the delivery of their financial services. Fintech refers to the application of technological breakthroughs to offer financial services and products to users (Arner et al., 2020). Adaba et al. (2019) and Dwivedi et al. (2021) highlighted the significant impact of Internet banking in fostering socioeconomic resilience. The advancement of Information and Communication Technology (ICT) has completely transformed financial businesses, allowing for increased operational effectiveness and better ecological sustainability (Yan et al., 2021). Li et al. (2022) emphasized the necessity of expanding the range of financial depth to achieve environmental sustainability. Previous studies have established that technical innovation is a key factor in defining EP (Awawdeh et al., 2022).

Digital technologies provide novel prospects for the advancement of inventive approaches to funding (IEA, 2021). The energy sector perceives fintech as a disruptive force because of its innovative nature and significant impact. Promoting the utilization of funds for energy efficiency has significant social, environmental, and ecological advantages (Deng et al., 2019). Puschmann et al. (2020) assert that the integration of green finance and fintech is crucial in attaining the clean energy objectives essential for sustainable development. Moreover, Kim (2018) has underscored the significance of banks' participation in financing low-carbon energy initiatives. Vogel et al. (2019) argue that blockchain technology has generated environmentally and economically viable products, hence enhancing the circular economy.

2.3. Environmental Sustainability and Energy Efficiency

A study is being carried out to assess the relationship between environmental concerns and macroeconomic factors in recent decades. Several studies have been conducted to examine the impact of energy use and economic growth on the environmental degradation of developing economies. The majority of the studies concentrated on a group of nations with a combination of different income levels.

The literature evaluation demonstrated a favorable correlation between energy demand economic upswings and ecological chaos energy. (Taghizadeh-Hesary and Rasoulinezhad, 2020) examined how efficiency growth and convergence contribute to improving economic production by utilizing inputs and adopting technology in a dataset spanning 36 years and covering 104 nations. Global environmental efficiency has shown improvement due to changes in energy pricing, as indicated by a study. Sun et al. (2020) affirmed the presence of the Environmental Kuznets Curve (EKC) theory and presented evidence of the negative impact of renewable energy on the environment. Environmental efficiency is essential for the potential emergence of the EKC. Actions such as improving energy efficiency, adjusting energy pricing, reducing energy intensity, promoting technological innovation, and establishing high-tech industries can contribute to achieving it.

The Environmental Kuznets Curve (EKC) hypothesis was confirmed in thirteen countries by Uchiyama and Uchiyama (2016). They examined the relationship between 18 economic indicators and environmental impact. Furthermore, the increase in population and economic instability are primary factors contributing to environmental degradation (Galeotti et al., 2009). Additionally, Yoshino et al. (2021) suggested that energy transactions can enhance economic and environmental efficiency. They found that energy transfer varies between nations with different wealth levels. Zafar et al. (2010) proposed that giving priority to low-carbon options can effectively improve environmental conditions while sustaining economic growth.

3. THE MODEL, DATA, AND METHODOLOGY

Our data is annual and covers the period 2012-2023 for the following Middle Eastern countries: Turkey, Saudi Arabia, Kuwait, Qatar, and the United Arab Emirates. Previous studies indicate that green finance, environmental sustainability, and FinTech play significant roles in energy efficiency (Cen and He, 2018; Alquliti, 2022). The econometric model evaluated the relationship between green finance, environmental sustainability, FinTech, and energy efficiency. The cross-sectional units are represented by i and t captures the time dimension of the panel. According to previous studies, the following model in our analysis was built:

$$EE_{it} = GF_{it}. FT_{it}. ES_{it}. \varepsilon_{it} \quad (1)$$

3.1. Cross-Sectional Dependence Test

The panel exhibits variations in slope and interdependence among its cross-sections. The initial step in our inquiry is examining and assessing the attributes of our panel dataset to determine if there is any cross-section dependence and variation in slopes. Member countries on the panel may exhibit similarities in certain aspects while diverging in others. Therefore, neglecting to consider the potential diverse characteristics in an empirical model might lead to biased analysis, particularly in the case of panel analysis. Given the potential heterogeneity across the cross-sectional units, the second-generation techniques are utilized in this context. The Pesaran (2004) cross-section dependence (CSD) test is employed to analyze the presence of cross-section dependence.

3.2. Unit Root

The second step entails doing a stationarity analysis in the chosen panel, which encompasses both cross-sectional and time series dimensions. This analysis is aimed at effectively addressing the issue of heterogeneous panels and resolving the problem of cross-section dependence among the cross-sectional components. In this analysis, the panel unit root tests used are IPS, developed by Im et al. (2003), and CIPS, established by Pesaran (2007). The null hypothesis posits the presence of a unit root in the data.

3.3. Panel Cointegration Test

After confirming the presence of serial dependence and unit roots in the panel data, it is crucial to assess whether the variables are cointegrated. In the context of cointegration, the Westerlund (2007) error correction model (ECM) was utilized to address issues such as varying slope parameters and cross-section dependence. In order to assess the long-term relationship between variables, we applied the Kao residual cointegration test developed by Kao et al. (1999).

3.4. Dumitrescu and Hurlin Causality Tests

Illustrating the relationship between dependent and independent variables involves using long-term estimation methodologies. However, determining the short-term causal relationship's direction is crucial for effective policymaking. A causality check was developed by Dumitrescu and Hurlin (2012) to establish the causal relationship between the variables. Variables are analyzed using the vector autoregressive (VAR) technique, which accounts for unobserved heterogeneity. Separate regressions for each cross-section establish causal relationships between variables.

4. EMPIRICAL RESULTS AND DISCUSSION

CD evaluation is the primary focus in current literature, impacting outcomes (Ahmed et al., 2022). CD and LM investigations are concisely presented in Table 1. The data are statistically significant at the 1% level and support rejecting the null hypothesis. In Table 1, the presence of CD confirms the utilization of second-generation unit root evaluations to analyze the integration order of the variables.

Tests are utilized to determine if a time series variable exhibits a unit root when analyzed in panel data tests. IPS and CIPS technologies are utilized for this purpose, and the outcomes of both tests are summarized in Table 2. The results of the IPS test indicate that green finance, environmental sustainability, FinTech, and energy efficiency show a unit root at the level. These variables do not exhibit a unit root in their first difference and are integrated

Table 1: Cross-sectional dependence tests results

Variable	Breusch-Pagan LM	Pesaran scaled LM	Pesaran CD
GF	96.04*	18.06*	13.83*
FT	181.71*	46.62*	15.41*
ES	170.12*	45.01*	16.62*
EE	179.64*	44.16*	13.42*

*, ** and *** is for the significance level of 10%, 5% and 1%

Table 2: Panel unit root test

Variables	IPS		CIPS	
	Level	Fist-difference	Level	Fist-difference
GF	−2.027	−3.321*	−2.334	−3.495*
FT	−2.059	−3.689*	−4.455*	−5.019*
ES	−1.570	−3.027**	−1.083	−3.053*
EE	−2.675	−4.396*	−2.068	−4.873*

*, **, and *** Denotes rejection of the null hypothesis at 1% and 5% and 10% significance level

Table 3: Cointegration test

Westerlund (2007)				
Model	G_t	G_a	P_t	P_a
EE_{it}=GF_{it} FT_{it} ES_{it} ε_{it}	−5.061*	−35.448*	−16.021*	−37.722*
Kao residual cointegration test				
ADF				
t-statistics	−1.311**			
P	0.0119			

*, ** and *** is for the significance level of 10%, 5% and 1%

at 1(1). The CIPS panel unit root test results show a unit root at the level for all variables except for FinTech. However, when we take the first difference, all variables become stationary.

The statistical analysis utilized the residual co-integration test developed by Kao et al. (1999) and Westerlund (2007) to assess co-integration. The conditional panel ECM provided error correction estimates for both the mean group and the panel. Additionally, (Gτ and Gα) and (Pτ and Pα) were considered. The Kao-residual co-integration test revealed a statistically significant long-term relationship between GF, FT, ES, and EE, with a significance level of 5%. The null hypothesis, which suggests the absence of co-integration between the variables, was rejected. These results suggest the presence of co-integration among the examined variables. The empirical findings presented in Table 3 demonstrate the presence of co-integration among the examined variables.

The estimates obtained from paired panel causality tests are presented in Table 4. Dumitrescu and Hurlin (2012) have established unidirectional and bidirectional causation between the variables being studied. A bidirectional causal relationship between “environmental sustainability and energy efficiency,” “green finance and energy efficiency” and “FinTech and energy efficiency” is confirmed by the test below.

The statistics indicate a positive correlation between FinTech events and energy conservation utilization, as reported by Anh Tu et al. (2021). The emergence of FinTech is a direct response to the growing adoption of energy-saving practices in the energy sector (Iqbal et al., 2021a). The FinTech industry also enables the focus

Table 4: Pairwise Dumitrescu-Hurling panel causality analysis

Null hypothesis	W-statistic	Zbar-statistic	P-value
EE does not homogeneously cause GF	4.210*	3.023	0.000
GF does not homogeneously cause EE	5.001*	4.083	0.000
EE does not homogeneously cause FT	4.321*	5.014	0.000
FT does not homogeneously cause EE	4.672*	4.611	0.000
EE does not homogeneously cause ES	4.662*	4.211	0.000
ES does not homogeneously cause EE	3.428*	3.128	0.000

*, ** and *** is for the significance level of 10%, 5% and 1%

and spread of information. The cumulative benefits have been demonstrated to facilitate the development of the renewable energy sector (Alemzero et al., 2021). The statistics indicate a positive correlation between FinTech events and the utilization of energy conservation, as reported by Anh Tu et al. (2021).

Green financing has a substantial influence on energy efficiency. Enhancing energy efficiency can be achieved by establishing specialized policy groups that focus on attaining energy poverty objectives (Liu et al., 2022). Governments and politicians should enact legislation to reduce domestic energy consumption and greenhouse gas emissions and enforce them to alleviate the effects of energy poverty on low-income families.

5. CONCLUSION AND POLICY IMPLICATIONS

This study investigated the correlation among green finance, environmental sustainability, FinTech, and energy efficiency. This study presents an empirical assessment of the impact of green finance, environmental sustainability, and FinTech on energy efficiency in Middle Eastern countries from 2012 to 2023. To accomplish this objective, the study began the empirical analysis by determining the existence of a CD in the data. After identifying the presence of CD in the series, we conducted the IPS and CIPS second-generation unit root tests. The test findings showed that all variables displayed first-order stationarity. To account for the varied characteristics of the five nations under investigation, we employed the Westerlund (2007) methodology.

To achieve the goals outlined in the Paris Climate Agreement, the implementation of methods that support the use of renewable energy sources foster environmental innovation, and improve energy production were proposed. Green finance, sustainability, and FinTech are closely interconnected. The early phases of establishing renewable energy sources can be both risky and expensive. Policy support is crucial for fostering an environment that promotes the growth of this industry.

The following policy recommendations were proposed based on the findings: Firstly, Middle Eastern nations must accelerate the progress of eco-friendly financial products and enhance the capacity of banks and financial institutions to offer green credit facilities. There should be increased investment in the crucial investigation of methods to employ eco-friendly financial technology while reducing risk exposures (Udeagha and Muchapondwa, 2023).

For improved sustainability performance, political leaders and governments must endorse precise regulations for advancing fintech, especially in the banking sector (Udeagha and Breitenbach, 2023). Businesses should support the fintech industry by implementing legislation for these financial products.

REFERENCES

Adaba, G. B., Ayoung, D. A., Abbott, P. (2019), Exploring the contribution of mobile money to well-being from a capability perspective. The Electronic Journal of Information Systems in Developing Countries, 85(4), e12079.

Ahmad, M., Ahmed, Z., Bai, Y., Qiao, G., Popp, J., Oláh, J. (2022), Financial inclusion, technological innovations, and environmental quality: Analyzing the role of green openness. Frontiers in Environmental Science, 10, 851263.

Al-Kasasbeh, O., Alzghoul, A., Alhanatleh, H. (2022), Empirical analysis of air pollution impacts on Jordan economy. International Journal of Energy Economics and Policy, 12(4), 512-516.

Al-Kasasbeh, O., Khasawneh, O., Alzghoul, A. (2023), The real effects of FINTECH on the global financial system. International Journal of Professional Business Review, 8(3), e01725-e01725.

Al-Kasasbeh, O., Khasawneh, O.A.H., Alzghoul, A. (2023), The nexus between renewable energy consumption and economic growth: Empirical evidence from Jordan. International Journal of Energy Economics and Policy, 13(2), 194-199.

Alkasasbeh, O.M., Alassuli, A., Alzghoul, A. (2023), Energy consumption, economic growth and CO_2 emissions in Middle East. International Journal of Energy Economics and Policy, 13(1), 322-327.

Alquliti, Y. (2022), The Impact of Fintech, Green Finance, and Financial Inclusion on Energy Efficiency and Sustainability in GCC Countries (Doctoral Dissertation, Effat University).

Arner, D.W., Buckley, R.P., Zetzsche, D.A., Veidt, R. (2020), Sustainability, FinTech and financial inclusion. European Business Organization Law Review, 21, 7-35.

Awawdeh, A.E., Ananzeh, M., El-Khateeb, A.I., Aljumah, A. (2021), Role of green financing and corporate social responsibility (CSR) in technological innovation and corporate environmental performance: A COVID-19 perspective. China Finance Review International, 12(2), 297-316.

Cen, T., He, R. (2018), Fintech, Green Finance and Sustainable Development. In: 2018 International Conference on Management, Economics, Education, Arts and Humanities (MEEAH 2018). Netherlands: Atlantis Press. p222-225.

Charles, G., Philip, B. (2020), Green finance: Recent drifts, confrontation and prospect opportunities for sustainable development in India. Mukt Shabd Journal, 9(4), 1854-1865.

Deng, X., Huang, Z., Cheng, X. (2019), FinTech and sustainable development: Evidence from China based on P2P data. Sustainability, 11(22), 6434.

Dumitrescu, E.I., Hurlin, C. (2012), Testing for Granger non-causality in heterogeneous panels. Economic Modelling, 29(4), 1450-1460.

Dwivedi P, Alabdooli JI, Dwivedi R (2021) Role of FinTech adoption for competitiveness and performance of the bank: a study of banking industry in UAE. Int J Glob Bus Compet 16(2):130-138.

Fu, J., Ng, A. (2021), Scaling up renewable energy assets: Issuing green bond via structured public-private collaboration for managing risk in an emerging market. Energies, 14, 3076.

Galeotti, M., Manera, M., Lanza, A. (2009), On the robustness of robustness checks of the environmental Kuznets curve hypothesis. Environmental and Resource Economics, 42, 551-574.

Gibon, T., Popescu, L., Hitaj, C., Petucco, C., Benetto, E. (2020), Shades of green: Life cycle assessment of renewable energy projects financed through green bonds. Environmental Research Letters, 15, 104045.

Guang-Wen, Z., Siddik, A.B. (2023), The effect of Fintech adoption on green finance and environmental performance of banking institutions during the COVID-19 pandemic: The role of green innovation. Environmental Science and Pollution Research, 30(10), 25959-25971.

IEA. (2021), E7 Countries 2021 - Analysis - IEA. Available from: https://www.iea.org/reports/E7countries-2021 [Last accessed on 2021 Aug 05].

Im, K.S., Pesaran, M.H., Shin, Y. (2003), Testing for unit roots in heterogeneous panels. Journal of Econometrics, 115(1), 53-74.

Kao, C., Chiang, M.H., Chen, B. (1999), International R&D spillovers: An application of estimation and inference in panel co-integration. Oxford Bulletin of Economics and Statistics, 61(S1), 691-709.

Karaki, B.A., Al-Kasasbeh, O.M.A.R. (2024), Analyzing the banking sector-Fintech companies nexus in Jordan. WSEAS Transactions on Business and Economics, 21, 280-287.

Kim, J. (2018), Leverage the financing role of banks for low-carbon energy transition. In: Financing for Low-carbon Energy Transition: Unlocking the Potential of Private Capital. Germany: Springer. p189-210.

Li, X., Ozturk, I., Majeed, M. T., Hafeez, M., & Ullah, S. (2022), Considering the asymmetric effect of financial deepening on environmental quality in BRICS economies: Policy options for the green economy. Journal of Cleaner Production, 331, 129909.

Liu, H., Yao, P., Latif, S., Aslam, S., Iqbal, N. (2022), Impact of green financing, FinTech, and financial inclusion on energy efficiency. Environmental Science and Pollution Research, 29, 18955-18966.

Meo, M.S., Abd Karim, M.Z. (2022), The role of green finance in reducing CO_2 emissions: An empirical analysis. Borsa Istanbul Review, 22(1), 169-178.

Naeem, M., Farid, S., Ferrer, R., Shahzad, S.J. (2021), Comparative efficiency of green and conventional bonds pre- and during COVID-19: An asymmetric multifractal detrended fluctuation analysis. Energy Policy, 153, 112285.

Nguyen, T., Naeem, M., Balli, F., Balli, H., Vo, X. (2021), Time-frequency movement among green bonds, stocks, commodities, clean energy, and conventional bonds. Finance Research Letters, 40, 101739.

Pesaran, M. (2004), General diagnostic test for cross-sectional independence in panel. Journal of Econometrics, 68(1):79-113.

Pesaran, M.H. (2007), A simple panel unit root test in the presence of cross-section dependence. Journal of Applied Econometrics, 22(2), 265-312.

Polzin, F., Sanders, M. (2020), How to finance the transition to low-carbon energy in Europe? Energy Policy, 147, 111863.

Prakash, N., & Mahdvi, S. (2020), Green bonds driving sustainable transition in Asian economies: The case of India. Journal of Asian Finance, Economics and Business, 8(1), 723-732.

Puschmann, T., Hoffmann, C.H., Khmarskyi, V. (2020), How green FinTech can alleviate the impact of climate change-the case of Switzerland. Sustainability, 12(24), 10691.

Rasoulinezhad, E., Taghizadeh-Hesary, F. (2022), Role of green finance in improving energy efficiency and renewable energy development. Energy Efficiency, 15(2), 14.

Shkodina, I., Timoshenkov, I., Nashchekina, O. (2018), The impact of financial technology on the transformation of the financial system. Financial and Credit Activity Problems of Theory and Practice, 1, 417-424.

Sun, H., Kporsu, A.K., Taghizadeh-Hesary, F., Edziah, B.K. (2020), Estimating environmental efficiency and convergence: 1980 to 2016. Energy, 208, 118224.

Taghizadeh-Hesary, F., Rasoulinezhad, E. (2020), Analyzing energy transition patterns in Asia: Evidence from countries with different income levels. Frontiers in Energy Research, 8, 162.

Taskin, D., Dogan, E., Madaleno, M. (2022), Analyzing the relationship between energy efficiency and environmental and financial variables: A way towards sustainable development. Energy, 252, 124045.

Teng, M., Shen, M. (2023), Fintech and energy efficiency: Evidence from OECD countries. Resources Policy, 82, 103550.

Uchiyama, K., Uchiyama, K. (2016), Empirical analysis of the environmental Kuznets curve. In: Environmental Kuznets Curve Hypothesis and Carbon Dioxide Emissions, Springer Briefs in Economics. Tokyo: Springer.

Udeagha, M.C., Muchapondwa, E. (2023), Green finance, FinTech, and environmental sustainability: fresh policy insights from the BRICS nations. International Journal of Sustainable Development and World Ecology, 30(6), 633-649.

Udeagha, M.C., Ngepah, N. (2023), The drivers of environmental sustainability in BRICS economies: Do green finance and FinTech matter? World Development Sustainability, 3, 100096.

Vives, X. (2017), The impact of FinTech on banking. European Economy, 2, 97-105.

Vogel, J., Hagen, S., Thomas, O. (2019), Discovering Block-chain for Sustainable Product-service Systems to Enhance the Circular Economy. Available from: https://aisel.aisnet.org/wi2019/track12/papers/10

Westerlund, J. (2007), Testing for error correction in panel data. Oxford Bulletin of Economics and Statistics, 69(6), 709-748.

Yan, C., Siddik, A. B., Akter, N., & Dong, Q. (2021), Factors influencing the adoption intention of using mobile financial service during the COVID-19 pandemic: The role of FinTech. Environmental Science and Pollution Research, 1-19.

Yoshino, N., Taghizadeh-Hesary, F., Otsuka, M. (2021), COVID-19 and optimal portfolio selection for investment in sustainable development goals. Finance Research Letters, 38, 101695.

Zafar, M.W., Zaidi, S.A.H., Sinha, A., Gedikli, A., Hou, F. (2019), The role of stock market and banking sector development, and renewable energy consumption in carbon emissions: Insights from G-7 and N-11 countries. Resources Policy, 62, 427-436.

Zhou, Z., Chau, K.Y., Sibghatullah, A., Moslehpour, M., Tien, N.H., Shukurullaevich, K.N. (2024), The role of green finance, environmental benefits, fintech development, and natural resource management in advancing sustainability. Resources Policy, 92, 105013.

Zia, Z., Zhong, R., Akbar, M.W. (2024), Analyzing the impact of fintech industry and green financing on energy poverty in the European countries. Heliyon, 10(6), e27532.